Image quality improvement in FIB photomask repair system

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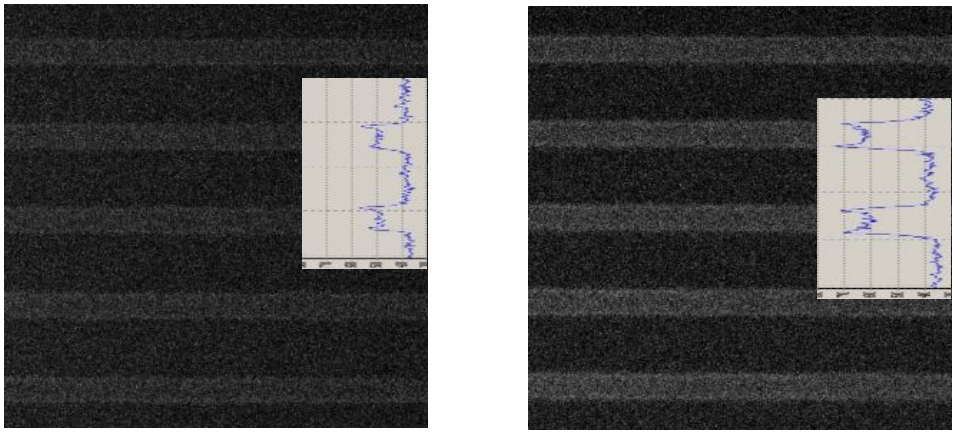
Focused ion beam (FIB) technology has widely been adopted as a defect repair tool on photomasks for semiconductor manufacturing. Requirement for the repair accuracy becomes much more severe with increasing pattern density of semiconductor devices.

In the FIB mask repair process, scanning ion image (FIB image) is used for the defect area recognition. Quality of the FIB images is one of the most important factors in order to improve the repair accuracy. Precise imaging of the small features on the photomasks, however, is challenging subject due to the surface charge build-up induced by FIB scanning, even though simultaneous electron beam irradiation is used for the charge compensation.

We have improved efficiency of secondary electron detection to enhance the quality of FIB images by re-arranging position of the secondary electron detectors. Furthermore, we have developed new method of the FIB scanning for better image quality. This method utilizes software accumulation of multiple images with different scan directions and results in higher peak-to-background ratio and higher contrast images with isolated mask patterns on the quartz substrate, comparing to the images acquired from conventional single scanning. The images also show better uniformity and symmetry of the secondary electron intensity. Attached figures are comparison of the conventional FIB image and the improved image of the photomask patterns. We have obtained much better repair accuracy and repeatability using the improved images.



(a) (b)

Fig.1: FIB images of photomask pattern:
(a) Conventional scanning method is used. (b) Newly developed scanning method is used. Both images are acquired with the same FIB dose. The line width of the pattern is 200nm. The insets show secondary electron intensity profiles.